

ATK THIOKOL PROPULSION

Hybrid Propulsion Testing at Marshall Space Flight Center

Presented by:

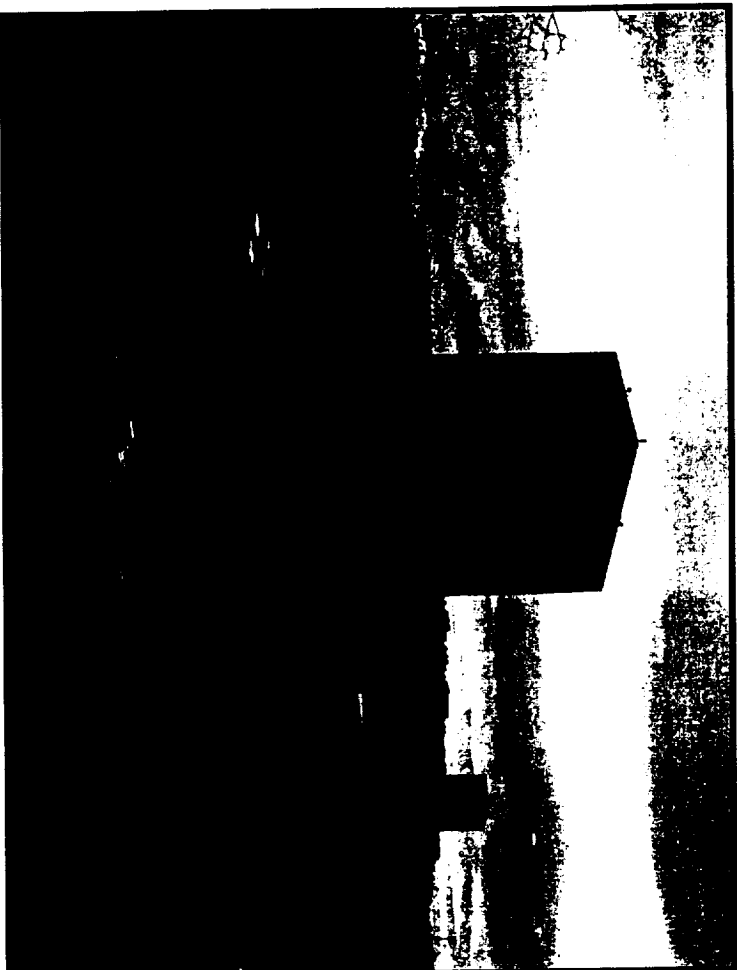
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July 9, 2002



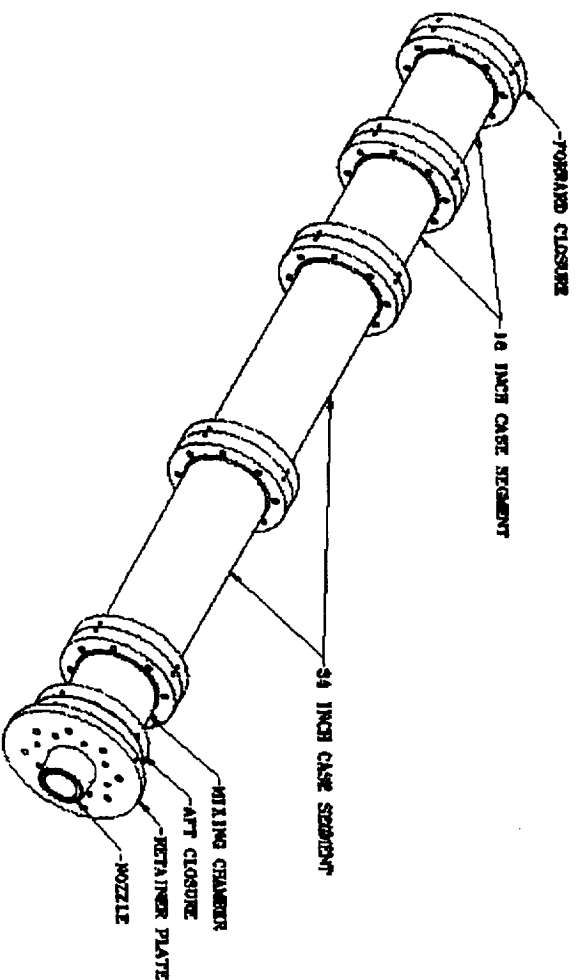
Scope

- We'll limit this discussion to hybrid work associated with Marshall Space Flight Center in Huntsville, Alabama.
- Others have done a great job of covering the more general history.



Solid Propulsion Investigation Program (SPIP)

- In the early 1990's, this program developed a small hybrid to simulate solid rocket motor environments for material testing.
- Different fuel formulations including GAP were used in the motor.
- With the addition of multiple longer case sections, the motor evolved into the 11-inch motor.



- **Nine companies, universities, and government agencies organized to form JIRAD.**
- **The program's objective was to initiate development of a national hybrid technology database and to address known technology deficiencies.**
- **The program performed extensive testing in laboratory scale, 11-inch, and 24-inch diameter motors at MSFC.**

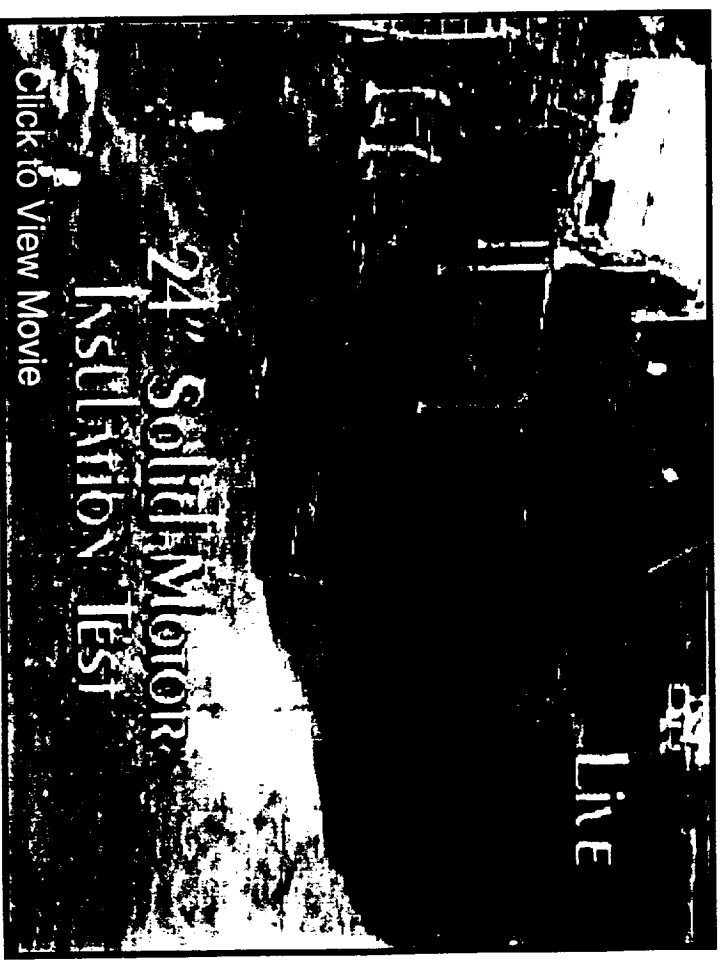


NASA NRA-93-MSFC-2

- NASA saw the need for a national engineering technology base for hybrids and released NRA-93-MSFC-2 with planned funding of \$36m.
- The objective was creation of a national engineering technology base that would allow the development of hybrids for commercial and government propulsion applications.
- Funding constraints caused major cutbacks and early termination of the program before its goals were achieved.

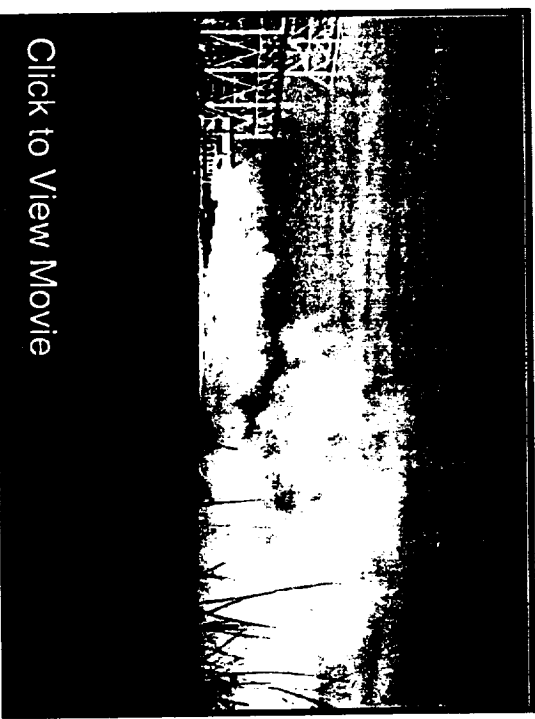
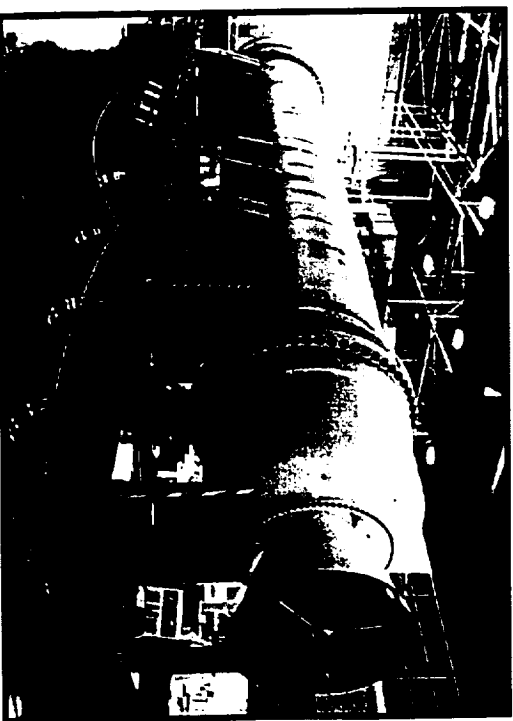
Large Subscale Solid Rocket Combustion Simulator (LSSRCS)

- LSSRCS was initiated to develop a large hybrid test-bed for solid rocket motor components.
- A hybrid test-bed had advantages of safety, over test capability, and controllability that were not available in solid rocket motor test-beds.
- The program did subscale testing in the 11- and 24-inch diameter motors at MSFC and created a preliminary design for a 35-foot long 6-foot diameter hybrid test-bed.
- Motors with multiple ports and separate injectors were tested. The program was terminated due to funding constraints.



Hybrid Propulsion Demonstration Program (HPDP)

- Industry and Government continued to see a need for a national engineering technology base for hybrids.
- A joint program was formed that included NASA, DARPA, Chemical Systems Division (CSD), Environmental Aerospace Corporation, Lockheed, Rocketdyne, and ATK Thiokol.
- The objective was to develop hybrids to a point that would allow commercialization for large boost motors.
- The program continued testing in the 11- and 24-inch hybrids and developed and demonstrated hybrid propulsion feasibility with four tests of a 250,000-pound thrust motor sized for an Atlas strap-on.
- The final large motor test occurred this January at Stennis.



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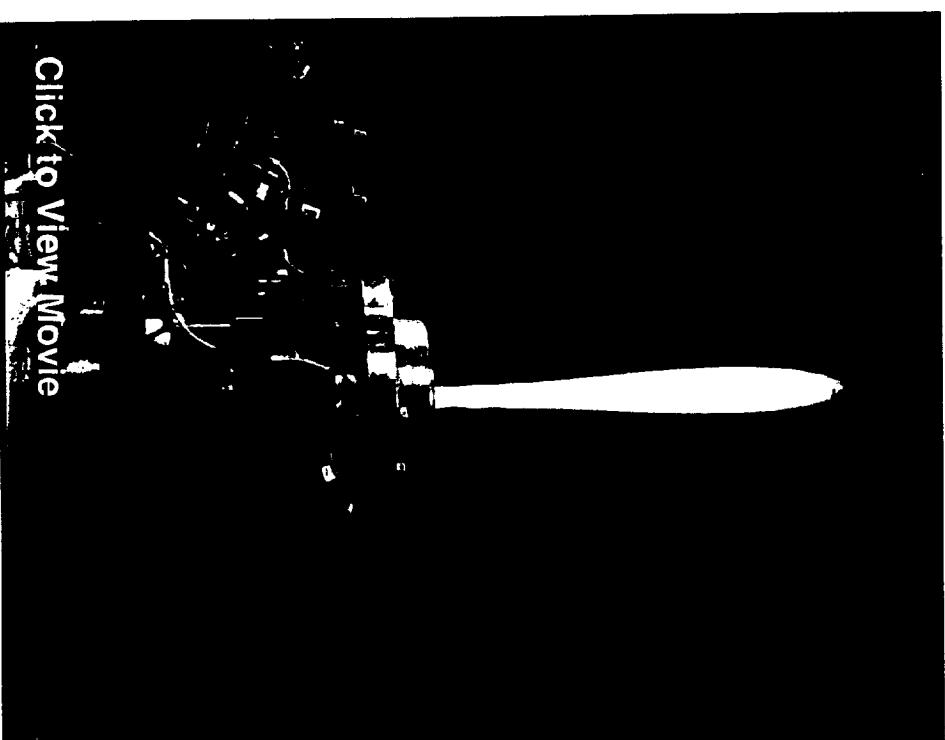
Hybrid Propulsion for Launch Vehicle Booster (HPTLV)

- ATK Thiokol conducted this program for the Navy using Marshall Test Facilities.
- It demonstrated feasibility of hybrids for a Navy launch application.
- Many flight design components including, tank, valves, and vectoring nozzle were demonstrated.



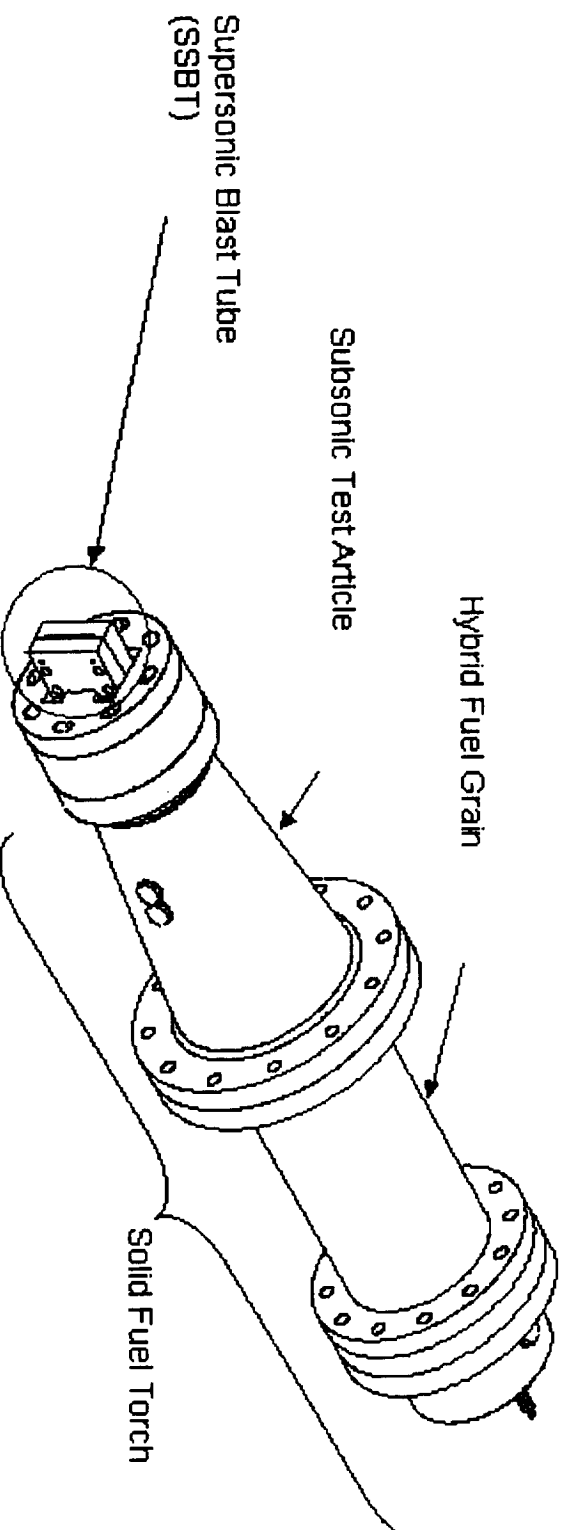
Peroxide Hybrid Upper Stage (PHUS)

- ATK Thiokol teamed with Lockheed and Rocketdyne to demonstrate the feasibility of hybrids for upper-stage propulsion.
- This program developed a gas generator fuel that eliminated many of the design and performance constraints of classical hybrids.
- Testing with peroxide as the oxidizer was performed in the workhorse 11- and 24-inch diameter motor hardware.



Solid Fuel Torch (SFT)

- This is a small, 5.0-inch diameter, hybrid used for testing nozzle and insulation materials.
- It employs water-cooled tungsten throat rings.
- An option adds a supersonic blast tube to provide particle impingement testing for exit cone materials.



Material and Component Testing

- **Some of the more exotic uses for hybrids have included:**
 - 1- Embedding multiple hydraulically activated seals in a test section to test performance under motor operating conditions.
 - 2- checking temperatures and flow rates of combustion gases through carbon fiber rope.
 - 3- providing combustion gases at controlled temperatures and fluxes for studying impingement effects on o-ring materials.